HUGHES Research Laboratories
A DIVISION OF HUGHES AIRCRAFT COMPANY
3011 MALIBU CANYON ROAD
MALIBU, CALIFORNIA

15 December 1964

RESEARCH CONTRACT STATUS REPORT

Title: Research on Gravitational Mass Sensors

Contract: NASW - 1035

Period: 15 November 1964 to 15 December 1964

I. ACCOMPLISHMENTS

16440

A cruciform sensor head and its associated vacuum chamber designed by Curtis Bell was fabricated for test purposes. The sensor head has four arms that vibrate tangentially to the direction of rotation. The arms are about 1.5 inches long. 0.75 inches wide and 0.050 inches thick with a 0.75 inch cube at the end for extra mass. The overall diameter is about 4.5 inches. The initial design frequency was 170 cps (with the speed of rotation to be 5100 rpm or 85 rps). Strain transducers were attached to the stationary sensor and response curves obtained. The Q in air at the resonant frequency (169.5 cps) was 150, but a spurious low Q response was found at 165 cps which was due to coupling of another sensor mode into the support. The sensor head was cut down to raise the operating frequency to 190 cps to move the desired response away from the spurious response. The reworked sensor has a clean resonance at 190 cps with a Q of 170 in air. The four strain transducers, one on each arm, are matched to within 1 dB and have a voltage-strain characteristic of 3.5×10^3 volts/unit strain. The associated vacuum chamber, which will be rotated along with the sensor head is 5.5 inches in diameter and 1.5 inches thick. This is enclosed in an external protective covering and motor mount. We are presently awaiting delivery of bearings, after which the entire structure will be reground for concentricity.

A high impedance, low noise preamplifier circuit has been selected for amplifying the signals from the high impedance strain transducers. The preamplifier will use a new type of field effect transistor, which are on order.

Readout from the rotating sensor chamber will be attempted with standard slip rings, which have been ordered. An alternate method of readout designed by Roger Morris involves inductive coupling between a static coil and a rotating coil containing a ferrite rod. A breadboard model was constructed and tested to demonstrate the feasibility of the concept and worked quite well. If the commercial slip rings prove unsatisfactory, then we will start a design and fabrication effort on such a unit.

A group at Hughes Aircraft Company in Culver City with considerable experience in fabrication of air bearing supported motors is preparing a preliminary estimate of the costs of fabricating a low noise air bearing unit to support and drive a sensor structure.

Curtis Bell has nearly completed an analysis of a three mass, two spring radially vibrating sensor structure. It is hoped that the introduction of the third mass at the center will eliminate the instability shown by the two mass, one spring system analyzed previously.

No problems have arisen which will impede the performance of the contract.

II. FUTURE PLANS

The ball bearing supported sensor will be assembled and tested. This work is primarily aimed at developing preamplifier and readout techniques as it is expected that the vibrational noise due to the mechanical bearings will be too large to allow us to see any gravitational intersections with this unit. A program to investigate very low level coherent detection of mechanical vibrations will intensify to see if it might be possible to get further under the noise of the high impedance preamplifiers. An air bearing supported motor will be fabricated. Further theoretical studies will continue. A paper, "Rotating Tensor Sensors," will be presented at the Berkeley meeting of the American Physical Society on 21 December 1964 by Robert Forward.

Prepared by: Robert L. Forward

Robert L. Forward
Principal Investigator